Fertilizer Placement for Connecticut Tobacco

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THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN

Bulletin 561 November, 1952

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The tobacco crop is more liberally fertilized than any other crop grown in Connecticut, with the possible exception of some vegetables. For more than 60 years, the composition and rates of application of the tobacco fertilizer have been the subject of many experiments by this Station and full reports on the results have been published. On the other hand, very few experiments have been made to determine the best distribution of the fertilizer in the soil, viz., where it should be placed in the soil with reference to the position of the roots.

The object of this bulletin is to discuss some fertilizer placement tests conducted on the Tobacco Laboratory Farm at Windsor during the last 10 years.

The time honored practice in fertilizing tobacco in Connecticut is to distribute the fertilizer mixture uniformly over the soil surface after plowing and then harrow or disc it into the upper few inches. In many other tobacco growing regions it is applied entirely in or adjacent to the row with the idea that the plants can more readily use the nutrients when they are placed within easier reach of the roots. Thus, the grower may use less fertilizer. Which is the most economical and which will produce the better quality and yield—broadcast or row application?

During the last 20 years many agronomists in other states have been interested in this question and the results of many field tests with a variety of row crops have been published in detail. A review of these experiments shows that no universal rule can be laid down for all crops nor even for the same crop in different locations. Briefly, the best fertilizer placement depends on (1) the crop, (2) the soil, (3) the weather, and (4) the amount and composition of the fertilizer. The only reliable way to answer the question for any crop in a given region is to compare the two methods over a period of years on adjacent replicated plots in the locality. Such a series of tests

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was conducted on the Tobacco Laboratory Farm in Windsor over a five-year period, 1940-1945. The results were published and analyzed in detail in the report of the Tobacco Experiment Station at the close of the experiments.[1] The reader is referred to that bulletin for full information. Only the most pertinent results need to be stated at this time:

1. Row application usually improved the grading but did not increase the average yield.

2. When the fertilizer was applied in bands close to the row, the quantity of fertilizer could be reduced below that required for broadcast without impairing the cash value of the crop.

3. During dry seasons there was considerable root injury from a too strong fertilizer solution in the soil, if the entire dose of fertilizer was within four inches of the plants. The plants were stunted and many failed to start, thus necessitating considerable restocking.

The danger of this root burning is the most serious objection to row application in this State and probably accounts for the fact that it is almost never practiced here. In regions where row application is practiced for tobacco, as in the cigarette tobacco sections of the South, the acre rate of fertilizer application has always been much lower than here and, therefore, involves less danger. Uniform distribution by broadcasting is not so wasteful of fertilizer, when one considers the speed with which the roots spread through the top soil. Before the plants are 15 inches high, the root tips from adjacent rows are intermingling midway between rows. With such rapid and complete permeation of the soil by the feeding roots, there is little need for concentrating the fertilizer supply immediately adjacent to the row. For Connecticut conditions the presently practiced broadcasting method is better than row application.

The above described tests were concerned with the horizontal or lateral distribution of the fertilizer. There is still the question of the vertical distribution, viz., how deep in the soil should the fertilizer be buried and should portions of it be placed at different depths? To obtain information on this, two long-term series of field tests were conducted. These were designated as the "plow under" series and the "plow sole" series. They will be discussed separately, although they were on the same field in randomized plots and some of the plots were included in both series.

[1]Anderson, P. J., and T. R. Swanback. Band application of tobacco fertilizers. Report of the Tobacco Substation at Windsor for 1944. Conn. Agr. Exp. Sta. Bul. 487: 259-274. 1945.

PLOW UNDER SERIES

The soil of the field on which these plots were located is a sandy loam of the Merrimac series similar to the soil on which a large part of the Connecticut tobacco crop is grown. The substratum is coarse sand, making the field subject to leaching in very wet weather and to drouth injury in dry weather. The Havana Seed type of tobacco was used for the tests and was planted, tended, cured and sorted in the usual way. A standard 6-3-6 fertilizer applied at the rate of 3,500 pounds to the acre was used throughout the experiment. The organic portion of the mixture, cottonseed meal and castor pomace, supplied about three-fourths of the nitrogen. Plots of 1/20 acre were in quadruplicate and randomized on the field. The seasons during the eight years (1944-1952) of this experiment were quite variable, particularly with respect to rainfall. Therefore, the field was irrigated during the too dry seasons (five times in 1948) while during two of the seasons of excessive rainfall, additional fertilizer was applied as a side dressing. Since these are common practices among the growers and, since all plots received the same treatment, this would not affect the conclusions. The variation in seasons was not greater than would normally be expected during eight consecutive years.

The tobacco from the middle rows of each plot was tagged and, after curing and stripping, was weighed and sorted into standard grades and lengths. In order to compare the quality of one plot with another, a "grade index" for each is calculated, after determining the percentage of each grade in a lot, by multiplying the percentage by the relative market value of the grade and adding the products. The grade index represents the relative market value per pound of any lot of tobacco.

On four plots the fertilizer was applied in the usual way by broadcasting it on the surface of the soil *after* plowing and then mixing it in the top three or four inches with a disc harrow.

On the other four plots, the fertilizer was distributed on the surface of the field *before* plowing and then the field was plowed and harrowed in the usual manner before setting the plants. By this practice, a larger portion of the fertilizer is distributed more deeply in the soil. It is not all buried to plow depth because the plow slice is not completely inverted but rests somewhat on edge against each adjacent slice.

The yield and grading results for the eight years are shown in Table 1.

Table 1. Plowing the Fertilizer under Versus Harrowing It in after Plowing. Eight Years' Comparison.

Fertilizer Placement	Plot No.	Yield, Pounds per Acre								
		1944	1945	1946	1947	1948	1949	1950	1951	Av.
Broadcast after plowing	1	2051	1828	1952	1844	1636	1910	1826	1979	1818
	2	1873	1922	1810	1752	1708	1748	1750	1868	
	3	1858	1852	2093	1825	1610	1916	1754	1835	
	4	1603	1711	1778	1657	1702	1916	1838	1776	
Plowed under	1	1663	1570	1492	1802	1687	1780	1607	1492	1788
	2	2234	2016	1725	2066	1864	2143	1935	1688	
	3	1551	1711	1494	2015	1748	2183	2000	1778	
	4	1933	1828	1674	1892	1450	1883	1650	1660	
		Grade Index								
		1944	1945	1946	1947	1948	1949	1950	1951	Av.
Broadcast after plowing	1	.393	.373	.454	.444	.321	.443	.402	.446	.406
	2	.344	.429	.410	.458	.327	.413	.452	.412	
	3	.364	.379	.513	.464	.299	.457	.472	.433	
	4	.270	.383	.406	.463	.313	.419	.427	.426	
Plowed under	1	.309	.321	.403	.455	.358	.418	.388	.302	.399
	2	.389	.399	.391	.484	.459	.528	.456	.442	
	3	.277	.361	.378	.467	.359	.484	.457	.374	
	4	.367	.361	.431	.454	.257	.468	.402	.349	

It is apparent from an examination of this table that one can judge nothing from one year's test because the advantage shifts year by year from one treatment to the other. There is also considerable variation in both yield and grading between plots treated alike. The eight-year average differences in both yield and grading are too small to be significant.

We may conclude from these tests that *a grower would not reap a larger or better crop by plowing the fertilizer under instead of spreading it on top after plowing and then harrowing it into the upper few inches.* However, if it were more convenient to plow it in or if he had other reasons for doing so, the crop would probably be no less in yield nor inferior in quality.

PLOW SOLE SERIES

During recent years there has been considerable interest among agronomists in evaluating the possible advantages of applying all the fertilizer on the plow "sole", i.e., the bottom of the plow furrow. (In our ordinary practice of plowing tobacco land, this would locate the fertilizer supply about eight inches deep.) For some crops in some regions this has increased the yield but in other tests it has not. No information on such tests with tobacco, however, has come to the attention of the writers. A fertilizer hopper carried on the plow or the tractor makes this a simple and easy method of applying fertilizer and, moreover, saves labor since it eliminates the operation of going over the field with the fertilizer spreader.

In view of the general interest in the subject and with the thought that we might find a better method of applying fertilizer, the "plow under" field test described above was enlarged in 1947 to include:

1. Four plots to which *all* the fertilizer was applied on the plow sole.
2. Four plots to which *one-half* the fertilizer was applied on the plow sole and the other half was harrowed into the surface soil in the usual way after plowing.

This test was continued for five years, 1947-1952, on the field described above. With four application methods to compare, all the plots were randomized in 1947, after which no changes of location were made for any one treatment during the five years. Planting, culture, harvesting, grading and calculation of results were the same as described above for the "plow under" series. During the five years the growing seasons ranged from very dry to too wet and, therefore, the results are such as could be expected in any period of five years in Connecticut.

It was quite apparent from field observations every year that the tobacco in "all plow sole" plots was slow in starting, small, stunted, and had a starved look, particularly during the first part of the growing period. There was usually some recovery later in the season but the plants never attained the size and spread of the adjacent plots. The inferior yield and quality of these plots is indicated in Table 2, where the grading and yield results of the five years are presented. The falling off in yield and grading was more pro-

nounced during seasons of heavy rainfall such as 1948; and least apparent during very dry seasons such as 1949.

Table 2. Plow Sole Placement of Fertilizer Compared with Broadcasting. Five-Year Summary.

Fertilizer Placement	Plot No.	Yields, Pounds per Acre 1947	1948	1949	1950	1951	Av.
Broadcast	1	1844	1636	1910	1826	1979	1793
	2	1752	1708	1748	1750	1868	
	3	1825	1610	1916	1754	1835	
	4	1657	1702	1916	1838	1776	
Plow Sole	1	1470	1174	1740	1320	1521	1516
	2	1641	1200	1759	1530	1484	
	3	1744	1379	1845	1748	1406	
	4	1520	1268	1765	1335	1469	
½ Plow Sole ½ Broadcast	1	1784	1299	1966	1766	1783	1868
	2	1856	1628	2097	1931	1955	
	3	1874	1647	2045	2083	1857	
	4	1930	1763	2152	1940	1996	
		Grade Index					
		1947	1948	1949	1950	1951	Av.
Broadcast	1	.444	.321	.443	.403	.446	.415
	2	.458	.327	.413	.452	.412	
	3	.464	.299	.457	.472	.433	
	4	.453	.313	.419	.427	.426	
Plow Sole	1	.100	.100	.344	.295	.281	.314
	2	.438	.100	.416	.346	.345	
	3	.414	.275	.396	.421	.288	
	4	.380	.210	.443	.364	.323	
½ Plow Sole ½ Broadcast	1	.404	.100	.420	.435	.413	.419
	2	.480	.305	.497	.488	.431	
	3	.484	.258	.463	.505	.458	
	4	.462	.383	.533	.435	.429	

RANKING

	Crop Index	Relative Crop Value
Broadcast	744.1	100.0
Plow Sole	476.02	64.0
½ Plow Sole ½ Broadcast	782.7	105.2

Results shown in this table lead to the conclusion that:

1. Placing all the fertilizer on the plow sole gave significantly lower yield and inferior quality.

2. With a half of the fertilizer on the plow sole and the other half harrowed into the surface, a higher yield was obtained but the difference in grading was not significant.

DISCUSSION

To produce maximum quality and yield of cigar tobacco in Connecticut, very heavy applications of mixed fertilizer are required. It is essential that the fertilizer be so located in the environment of the plant that abundant plant food is available to the roots at all times. It is well known that if the plants are checked in growth even for a short time for lack of nourishment, they never "catch up" and make the same growth as plants which were never checked. Plants, however, may be checked also by a too concentrated nutrient solution which kills or injures the roots. This happens when too much of the fertilizer is concentrated in a limited space such as is effected by a band application of the fertilizer placed too near the plants when they are set out. Moreover, such an extreme concentration of fertilizer is not needed. Harrowing distributes the fertilizer uniformly into the upper part of the soil, making available sufficient amounts of nutrients for young plants. Then, as the plant roots spread rapidly into the more distant parts of the soil, every rootlet finds nutriment within its reach. The optimum situation is attained when all the roots are surrounded by ample nutrient medium and every rootlet is absorbing and contributing its maximum to the food supply of the expanding leaves. When a part of the roots are in a nutrient-poor area, the plant's nutrient uptake is limited in proportion. Thus, when all of the fertilizer was placed on the plow sole, the young plants were badly stunted for all of the roots were in the poorer top soil. Later, when the root system had reached the plow sole, the growth was never normal because a part of the roots were still in the poorer unfertilized upper soil. On the other hand, the placing of a part of the fertilizer on the sole, while the remainder was worked into the upper layer, gave better nourishment to that part of the root system which grows at plow depth and somewhat deeper. This would explain the better yield where the fertilizer was divided between the sole and top layer as compared with the plots where it was all worked into the upper few inches.

The fact that the plow sole plots were so much poorer during wet years may indicate that the fertilizer was carried down into the sandy substratum by the excess water.

These experiments have limits to their general application in the fact that they were all on one type of soil and that only one fertilizer formula was used. It is possible that other soil types or other formulas might not react the same.

SUMMARY

1. Broadcasting the fertilizer in the usual way was preferable to drilling it in bands close to the row. Root injury by the fertilizer concentration is the main objection to the band method.

2. Distributing the fertilizer on the field before plowing did not give better results than the usual method of harrowing it in after plowing.

3. Placing all the fertilizer on the plow sole gave the plants a poor start, stunted them, and resulted in much reduced yield and poorer grading.

4. When one half of the fertilizer supply was placed on the sole and the other half was harrowed into the upper soil in the usual way, small increases in yield were obtained.